Solutions

Unit objectives *You will be able to…*

- **Identify parts o a solutions**
- **Calculate absolute and relative quantities of solution (mixtures; heterogeneous and homogeneous) components.**
- **Apply concepts of concentration units to stoichiometry**
- **Calculate Mole quantities in absolute terms for concentration and dilutions**
- **Calulate dilutions**
- **Make solutions to specific concentrations using volumetric glassware from both solid and liquid solutes**

Solubility

Not all ionic compounds dissolve!

Instead of doing experiments all the time to see which ones will dissolve, we use <u>The solubility rules.</u>

Solubility Rules

1. All nitrates (NO_3^-) are soluble.
2. All ammonium (NH_4^+) or alkali (Li^+, Na^+, K^+, Rb^+, Cs^+, Fr^+) compounds are soluble.
3. All carbonates (CO_3^{2-}), phosphates (PO_4^{3-}) and hydroxides (OH^-) are insoluble except with the cations in Rule #2.
4. All chlorides (Cl^-), bromides (Br^-), and iodides (I^-), are soluble except with Ag^+, Pb^{2+}, or Hg^+.
5. All sulphates (SO_4^{2-}) are soluble except with Ca^{2+}, Sr^{2+}, Ba^{2+}, Ra^{2+}, Pb^{2+},

Net Ionic Equation Review, cont. 3

Practice

Which of the following are soluble in water?

1. **$SrSO_4$**
2. **$NaNO_3$**
3. **$PbCl_2$**

Net Ionic Equation Review, cont. 4

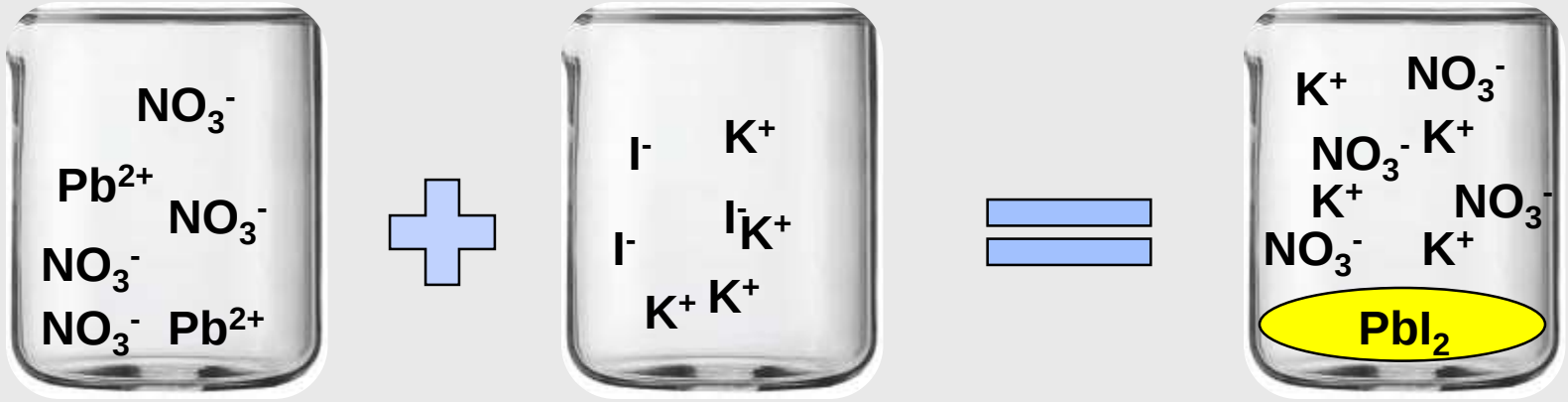
Predict the products of the following reaction: (if no solid precipitate is formed, there is no rxn)

$Pb(NO_3)_2(aq) + KI\ (aq) \rightarrow$

$Pb(NO_3)_2(aq) + 2KI\ (aq) \rightarrow PbI_2(s) + 2KNO_3\ (aq)$

We know it is a solid precipitate because it is insoluble according to the solubility rules.

View of the Rxn Ions



Because K^+ and NO_3^- remain dissolved, they are called spectator ions and are not included in the net ionic equation.

<u>Net Ionic Equation</u>

$$Pb^{2+}(aq) + 2I^-(aq) \rightarrow PbI_2(s)$$

Solubility Practice

Which are soluble

KCl

NH_4NO_3

AgCl

$CaSO_4$

Li_2SO_4

Precipitation Reactions

When a solid doesn't dissolve it is called insoluble.
A solid that forms when two solutions are mixed is called a precipitate.

Denoted as (s) in a chemical equations

Net Ionic Equation Review, cont. 8

Based on the reactants below, what is the precipitate and balance?

$Ca(NO_3)_2(aq) + Na_3PO_4(aq) \rightarrow$

BELL WORK
9-April-18

What is a solution?

Try explaining it as if you were writing to a friend not to Mr. Golden

What is an ionic compound?

Agenda:

Parts of a Solution

Polarity

Molarity

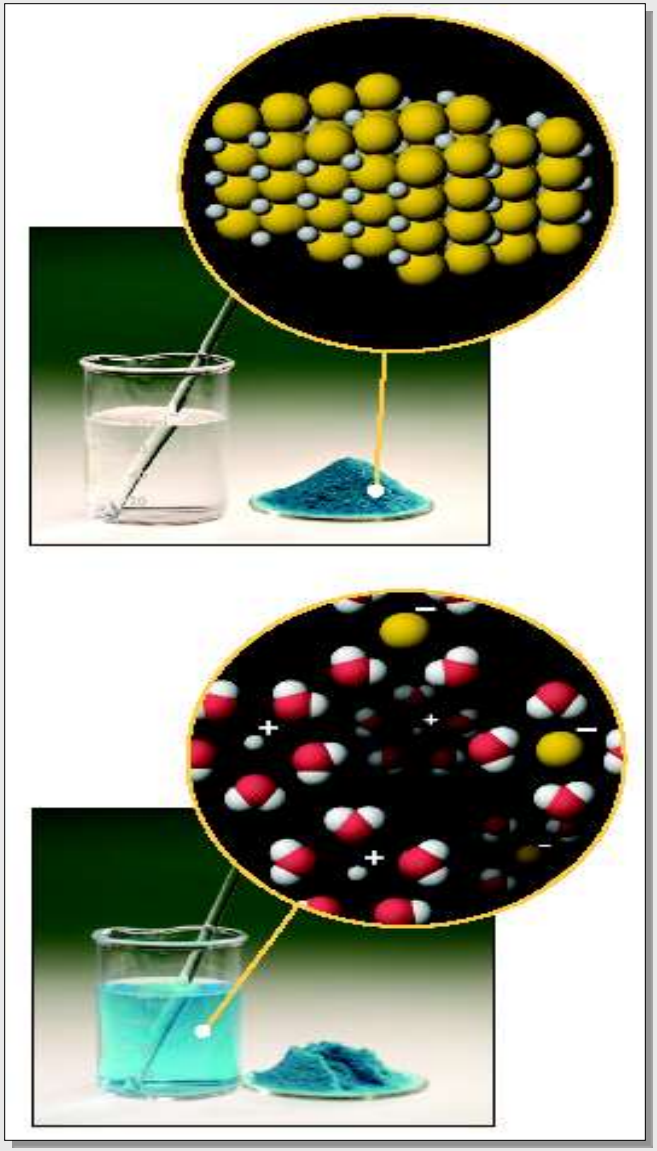
Objective: You will UNDERSTAND how to calculate molarity, and APPLY your knowledge to making solutions

Turn In, 9April18

- **Remainder of Stiochiometry**

Some Definitions

A solution is formed when a Solvent _____ and Solute _____ are mixed.



PARTS OF SOLUTIONS

SOLUTE –part of a solution that is being dissolved (usually the lesser amount)

SOLVENT –part of a solution that dissolves the solute (usually the greater amount)

Solute + Solvent = Solution

Definitions

Solutions can be saturated or unsaturated.

__Saturated__ solution contain the maximum amount of solute.

An __unsaturated__ solution contains less solute than a solvent can hold at a particular temp.

Definitions

<u>SUPERSATURATED SOLUTIONS</u>
contain more solute than a solvent can hold

They are unstable. The super saturation is only temporary, and usually accomplished in one of two ways:

To Make a Supersaturated Solution

1. **Warm the solvent so that it will dissolve more, then cool the solution**
2. **Evaporate some of the solvent carefully so that the solute does not solidify and come out of solution.**

Supersaturated Rock Candy

This supersaturated sucrose and food coloring solution uses a "seed" crystal to make…

Crystal Rock candy

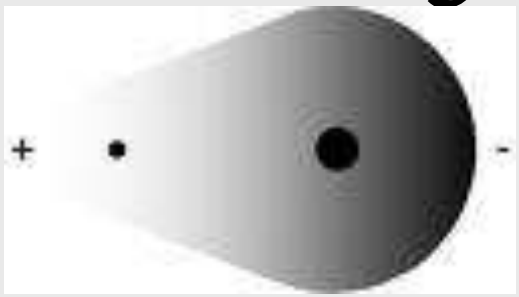
Factors affecting solubility

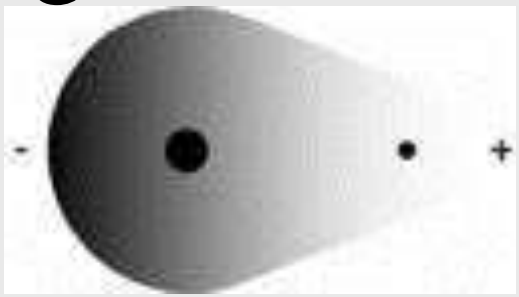
1. **Heat** increases solubility in most liquids

   * solubility of **gases** are greater in cold water than hot.

2. **True:** the solubility of gas increases w/ increasing pressure

Factors affecting solubility





3. Polar molecules will only dissolve in Polar molecules

Non- polar molecules will only dissolve in non-polar molecules

“like dissolves like”

RATE OF DISSOLUTION

Several Factor determine the rate a substance dissolves

1. **Agitation** helps a solute to dissolve because it brings fresh solvent into contact w/ the solute
2. A greater **Surface** area of solute is exposed to the colliding water molecules

RATE OF DISSOLUTION

Several Factor determine the rate a substance dissolves

3. Energy also influences the rate at which a substance dissolves. The higher energy leads to increased frequency and number of the collision of water molecules w/ crystal surfaces

Question

A solution is made up of 25 grams of cyclohexane (non-polar) and 7 grams of acetonitrile (polar).

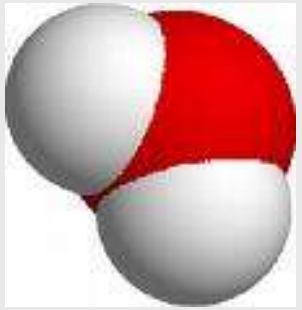
What is the solute ?

What is the solvent?

Would you expect the solvent to readily mix with the solute?

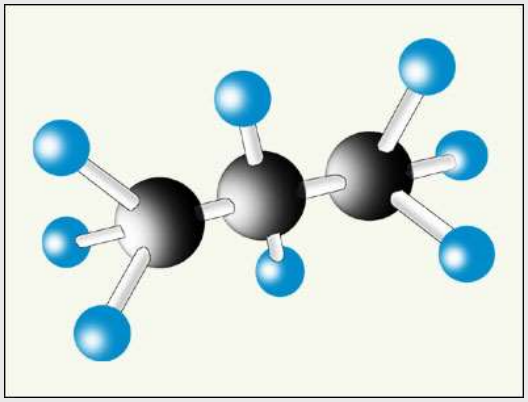
Polarity

"polar" molecules: An uneven distribution of electron density. Ex. water H_2O



“non polar” molecules: an even distribution of electron density.

Ex. Oil, propane, etc.



http://www.youtube.com/watch?v=PVL24HAesnc

http://www.youtube.com/watch?v=LKAjTE7B2x0&feature=related

Solution Quick Review

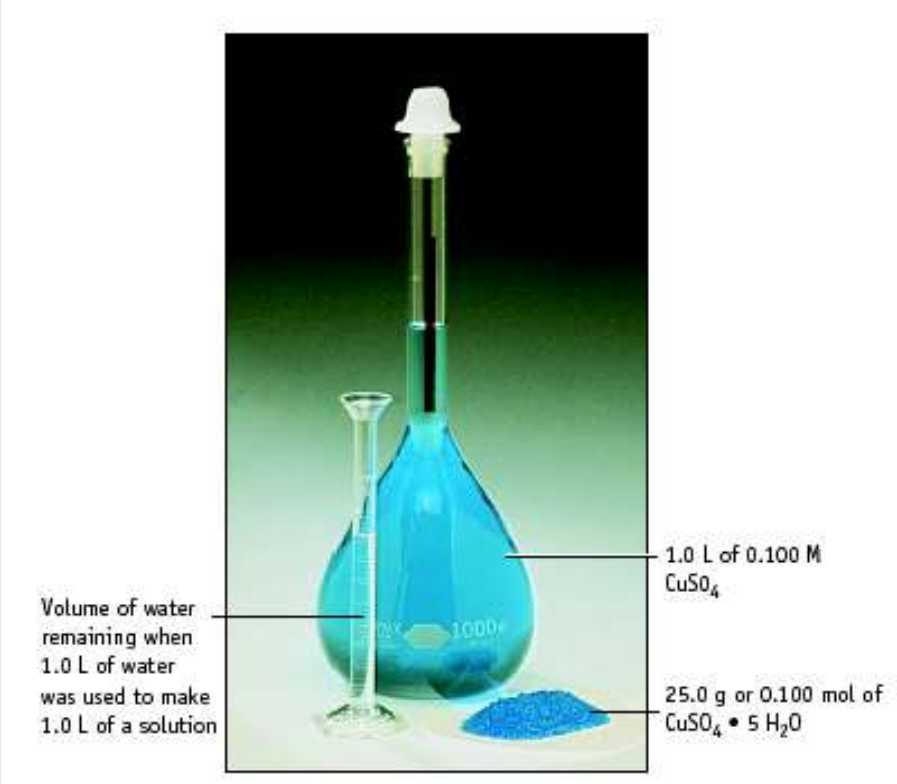
http://www.youtube.com/watch?v=9h2f1Bjr0p4

Concentration of a solution

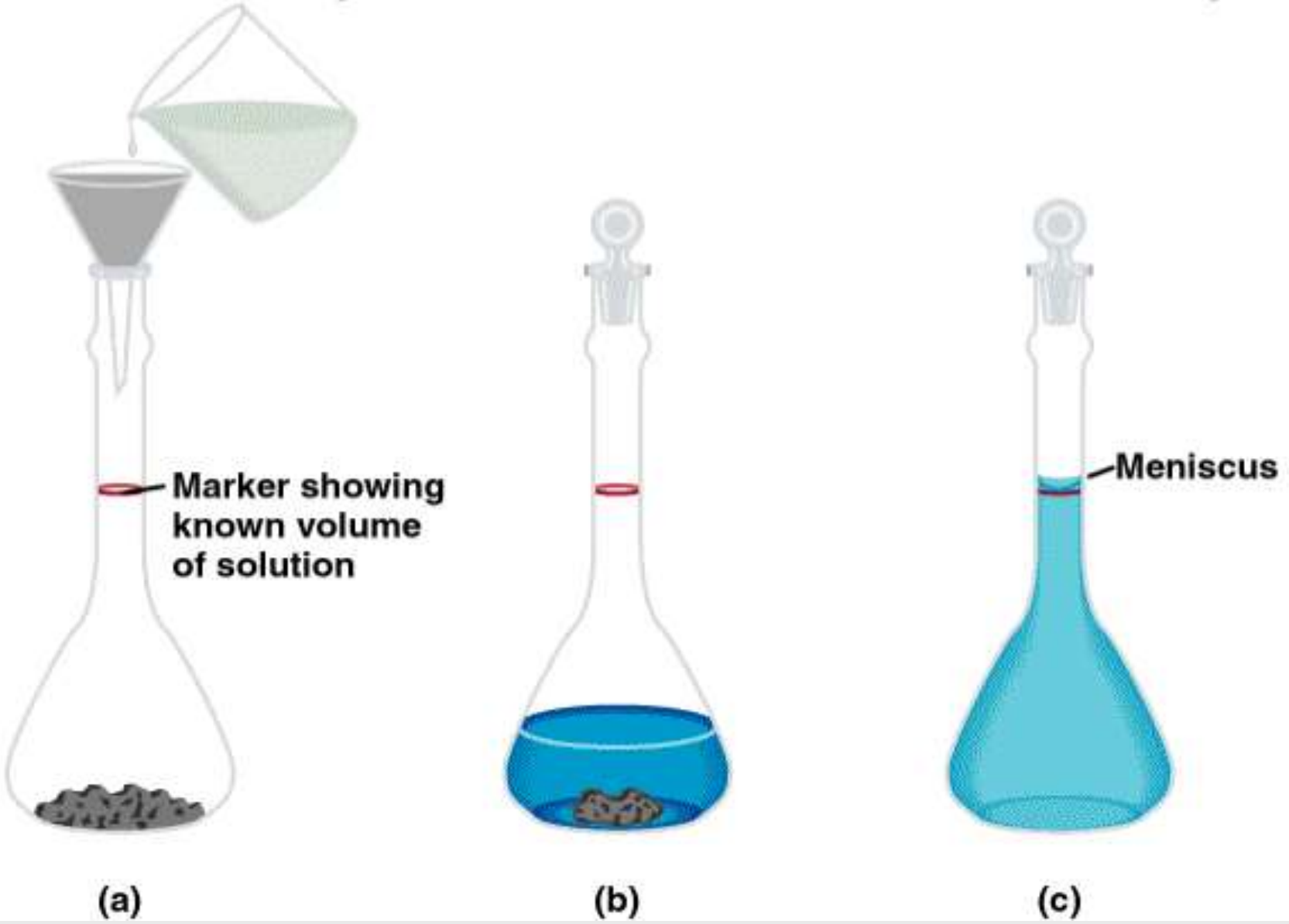
The amount of solute in a solution is given by its concentration.

$$\textbf{Molarity (M)} = \frac{\textbf{moles solute}}{\textbf{liters of solution}}$$

1.0 L of water was used to make 1.0 L of solution. Notice the water left over.

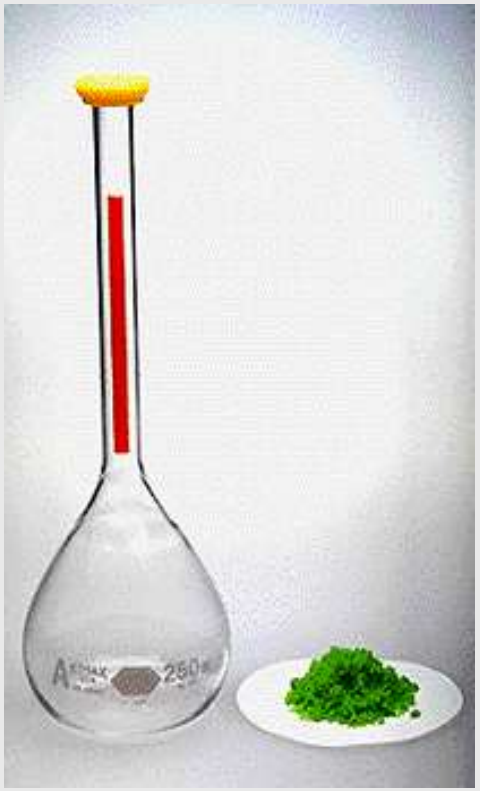


Preparing a Solution of Known Molarity



Practice

Dissolve 5.00 g of $NiCl_2$ in enough water to make 250 mL of solution. Calculate the Molarity.



Dissolve 5.00 g of $NiCl_2$ in enough water to make 250 mL of solution. Calculate the Molarity.

Step 1: Calc. moles of $NiCl_2$

$$5.00\ \text{g} \bullet \frac{1\ \text{mol}}{129\ \text{g}} = 0.0388\ \text{mol}$$

Step 2: Calculate Molarity

$$\frac{0.0388\ \text{mol}}{0.250\ \text{L}} = 0.155\ \text{M}$$

$[NiCl_2]$ = 0.155 M

Practice

What is the molarity of a 0.4L solution made with 0.5g $CoCl_2$ at 25°C.

How do you think temperature would affect the molarity?

Using Molarity

What mass of oxalic acid, $H_2C_2O_4$, is required to make 250. mL of a 0.0500 M solution?

$$\text{moles} = \frac{\text{mol}}{\text{L}} \times \text{L}$$

Using Molarity

What mass of oxalic acid, $H_2C_2O_4$, is required to make 250. mL of a 0.05 M solution?

$$\text{moles} = \frac{\text{mol}}{\text{L}} \times \text{L}$$

Step 1: mL → L.

$$250\ \text{mL} \times \frac{1\text{L}}{1000\text{mL}} = 0.250\ \text{L}$$

Step 2: Calculate.

$$\text{Mol} = \left(\frac{0.05\ \text{mol}}{1\text{L}}\right)(0.250\ \text{L}) = 0.0125\ \text{mol}$$

Step 3: Convert moles → grams.

$$(0.0125\ \text{mol})(90.00\ \text{g/mol}) = 1.13\ \text{g}$$

Two Other Concentration Units

MOLALITY, *m*

$$m \text{ of solution} = \frac{\text{mol solute}}{\text{kilograms solvent}}$$

% by mass

$$\%\ \text{by mass} = \frac{\text{grams solute}}{\text{grams solution}} \times 100$$

Learning Check

A solution contains 15g Na_2CO_3 and 235g of H_2O. What is the mass %(m/m) of the solution?

1) **15% Na_2CO_3**
2) **6.4% Na_2CO_3**
3) **6.0% Na_2CO_3**

With so many variations for representing concentrations of liquid solutions, why is it important for you to understand what each is representing

Lab Time
"Molarity Practice Lab"

$$\%\ \text{by m/v} = \frac{\text{g solute}}{\text{100mL solution}} \times 100$$

So… if we wanted a 100ml of 5.0%solution of $NiCl_2 \cdot 6H_2O$ we would:

Weight out: 0.05 = x / 100mL

x = 5.0g

Add 5.0g to 100ml volumetric flask and fill *to* 100ml with DI water

Practice makes Perfect

Calculate the molarity when 75.0g of $MgCl_2$ is dissolved in 500.0 mL of solution.

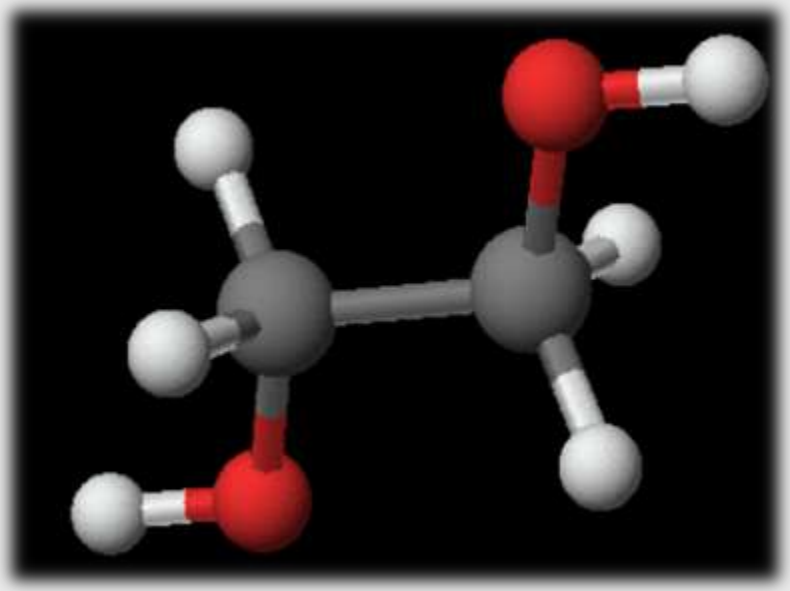
100.0g of sucrose ($C_{12}H_{22}O_{11}$)is dissolved in 1.50 L of solution. What is the molarity?

49.8g of KI is dissolved in enough water to make 1.00 L of solution. What is the molarity?

A chemist dissolves 98.4g of $FeSO_4$ in enough water to make 2.000 L of solution. What is the molarity of the solution?

Calculating Concentrations

Dissolve 62.1 g of ethylene glycol in 250.0 g of H_2O. Calculate molality *and* % by mass of ethylene glycol ($C_2H_4(OH)_2$).



Calculating Concentrations

Dissolve 62 g of ethylene glycol, $C_2H_4(OH)_2$, in 250g of H_2O and Calculate ~~the m~~ and % mass (by mass) of $C_2H_4(OH)_2$

~~**Calculate molality**~~

~~**Conc. (molality):** $\frac{1.00\ mol\ glycol}{0.25kg\ H_2O}$ = 4.0molal~~

Calculate weight %

$$\% \text{ glycol} = \frac{62g}{62g + 250g} \times 100\% = 19.9\%$$

Practice makes Perfect

What is the *molarity* of a solution made by dissolving 0.1356 g $MgSO_4$ to 200.0 mL in water?

What is the volume of 3.0 M solution of NaCl made with 526g of solute?

Battery acid is generally 3M H_2SO_4. Roughly how many grams of H_2SO_4 are in 400. mL of this solution?

How many grams of $Sr(ClO_4)_2$ are required to make a 0.30 *m* aqueous solution using 600 g of water?

Bell Work
16-April-2018

What volume of 0.5M Na_2CO_3 is needed to completely react with 2.0g of $HC_2H_3O_2$ in the balanced equations below?

$$\underline{1}Na_2CO_3 + \underline{2}HC_2H_3O_2 \rightarrow \underline{2}NaC_2H_3O_2 + \underline{1}CO_2 + \underline{1}H_2O$$

(Hint: find moles of Na_2CO_3 needed based on mass of $HC_2H_3O_2$ given using stiochiometry)

EQ: What is your most useful time of the year; summer recess or school session? Why?

Agenda:

~~Finish~~ Molarity lab

Objective: You will understand how to calculate molarity and percent solutions then make them in a laboratory setting

Bell Work
18-April-2018

When you have 100mL of a 0.5M solution of NaOH, how many mole of NaOH are present?

If 450mL of water is added what is the new molarity?

How does temperature affect solubility of solids in liquids? Give an example.
Gasses in liquids? Give an example

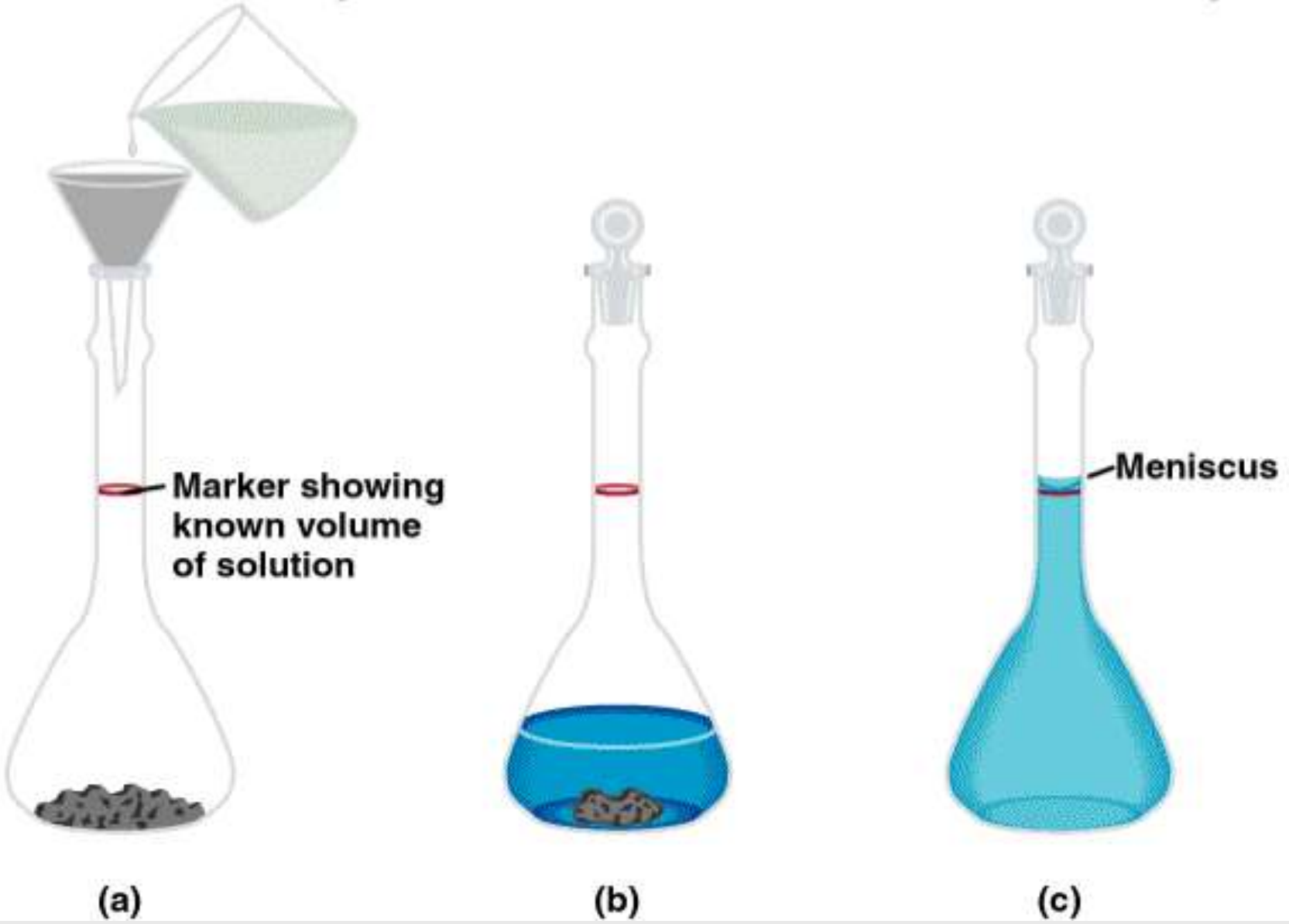
EQ: What is your most useful time of the year; summer recess or school session? Why?

Agenda:

Determining Molarity lab

Objective: You will understand how to calculate molarity and percent solutions then make them in a laboratory setting

Preparing a Solution of Known Molarity



Determining Morality Mini Lab

- Follow instructions exactly as written.
- If asked to add 30ml of water add 30ml of water
- No Pre-Lab!

Determining Morality Mini Lab

Calculate the molarities of the following solutions:

1) 2.3 moles of sodium chloride in 0.45 L of solution

2) 0.09 moles of sodium sulfate in 12mL of solution.

3) 120 g of calcium nitrite in 240mL of solution

4) 98 g of sodium hydroxide in 2.2 L of solution

Homework

Determining Molarity Lab, Molarity Calculation Practice #1-10,

Due ~~Monday~~Thursday 19.April.2018

Bell Work
19.April.2018

Have your Determining molarity lab out and ready to turn in.

Clear your desk for our assessment:

Green Sheets, pencil/ pen, calculator and periodic table.

1-2 pieces of college rule blank paper

Gases, Solutions, and Concentration. Pre AP Chem. 2018

Name

Gases, Solutions, and Concentration

Without skipping lines…

1.
2.
…
7.
8.
Ia.
Ib.
II.
III. a
III. b
IV. Step 1
Step. 2
Step. 3
Sept. 4
V. a
V. b
V. c
V. d

Show all work (including problem solving strategies for Free response Questions. Make sure to number and organize work by questions. If Mr. G can not read it… it is wrong

Turn in, 19.April.2018

“Molarity Practice” Lab
Making Solutions

Bell Work
20-April-2018

What is the molar mass of $NiCl_2$?
The molar mass of the hydrate $NiCl_2 \cdot 6H_2O$?

What are the steps to make a 100mL 1.2M $NiCl_2$ solution from solid $NiCl_2 \cdot 6H_2O$ and water using a volumetric flask?

Agenda:

Dilutions

~~Finish Polarity~~

Objective: you will understand how to use the dilutions formula and apply it in a laboratory setting

DILUTION

Going from one concentration to another

$$M_1V_1=M_2V_2$$

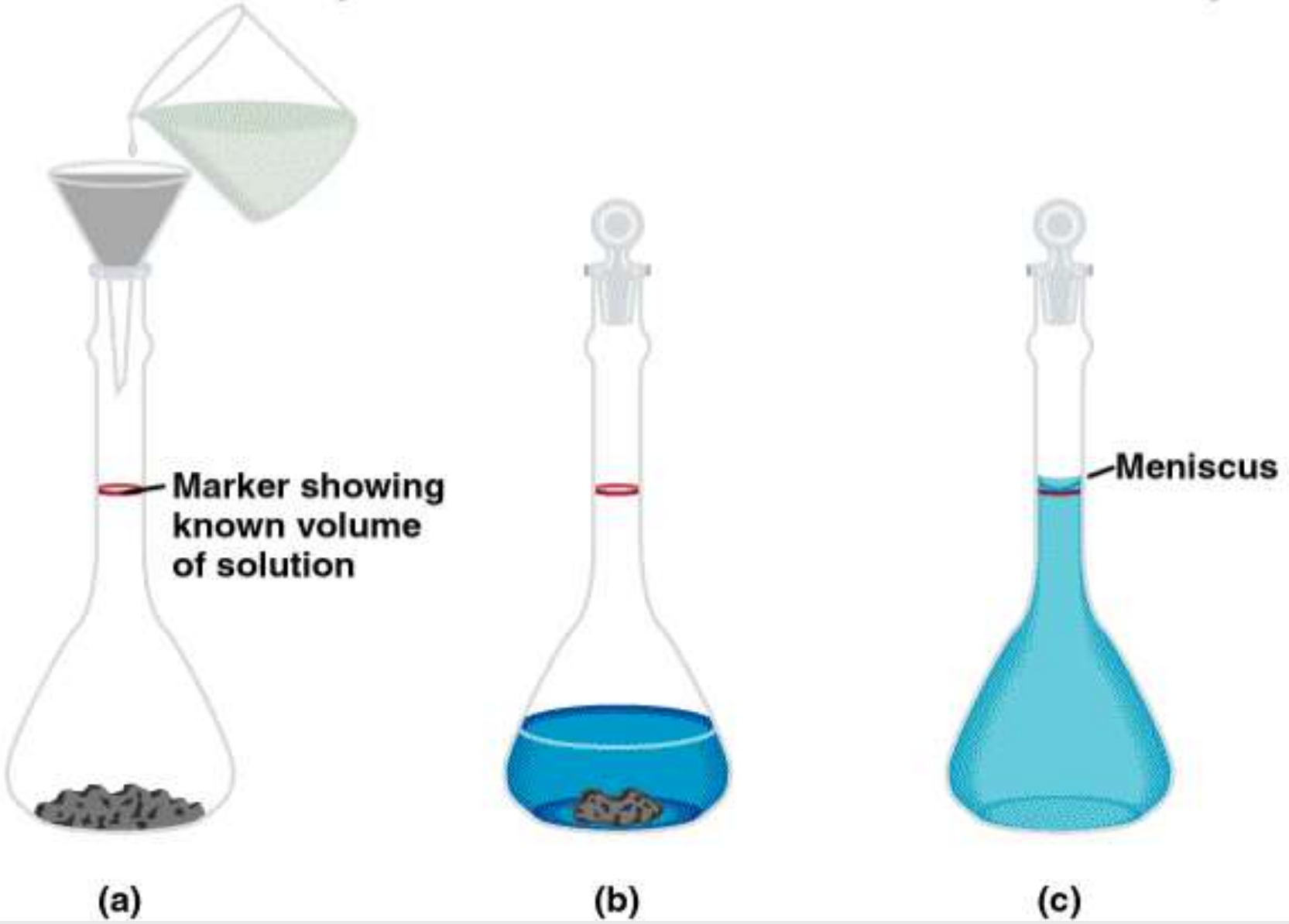
M = molarity (mol/L)

V = volume (what unit ????)

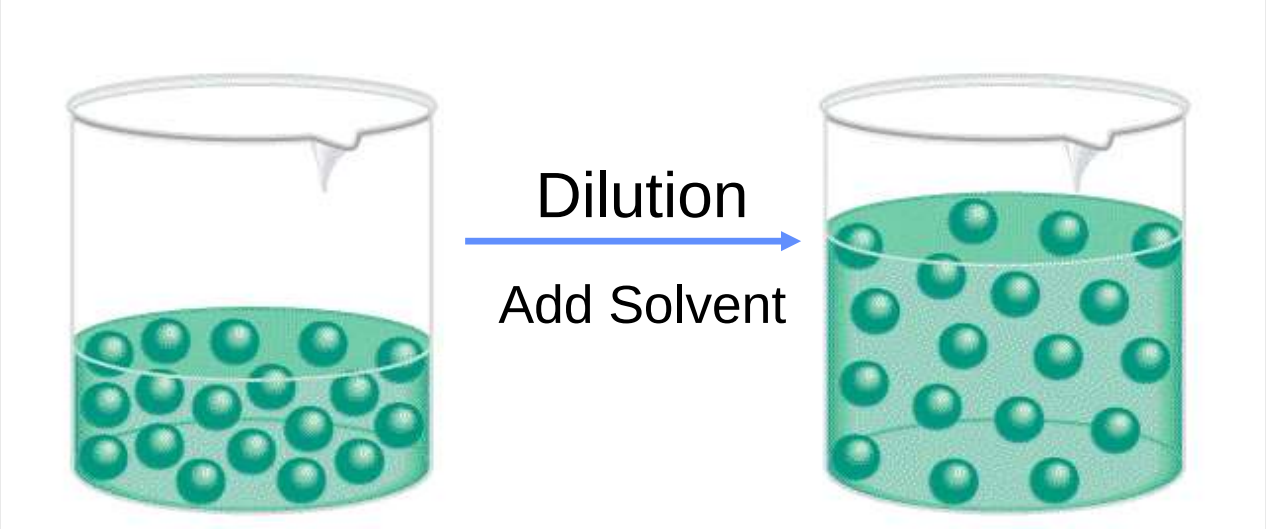
Starting/ what you have M_1 and V_1

Ending/ what you want M_2 and V_2

Preparing a Solution of Known Molarity



Dilution **is the procedure for preparing a less concentrated solution from a more concentrated solution.**



Moles of solute before dilution (i) = Moles of solute after dilution (f)

$$M_1V_1 = M_2V_2$$

How would you prepare 60.0 mL of 0.2*M* HNO_3 from a stock solution of 4.00 *M* HNO_3?

$$\boldsymbol{M_1V_1 = M_2V_2}$$

M_1 = 4.00M M_2 = 0.200M V_2 = 0.06 L V_1 = ? L

$$V_1 = \frac{M_2V_2}{M_1} = \frac{0.200\text{M} \times 0.06\text{L}}{4.00\text{M}} = 0.003\text{ L} = 3\text{ mL}$$

3 mL of acid + 57 mL of water = 60 mL of solution

DILUTION

What would the new molarity be of a 250ml 0.8M solution of HCl if it was diluted to 450ml?